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REPORT NO. FTDM-2199  
DATE: 23 August 1962

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MATERIAL - MONIKEL FASTENERS, ELECTROPLATED,  
GALVANIC CORROSION EFFECTS ON BASE K-0010-16  
ALUMINUM ALLOY - EVALUATION OF

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GENERAL DYNAMICS | FORT WORTH

## TEST DATA MEMORANDUM

F TDM NO. 2199  
MODEL B-58  
TEST NO. F-8198

TEST: MATERIAL - L-NICKEL FASTENERS, ELECTROPLATED, GALVANIC CORROSION EFFECTS ON BARE X-2219-T6 ALUMINUM ALLOY - EVALUATION OF

OBJECT: To evaluate the galvanic corrosion resistance of assemblies of sulfuric acid anodized X-2219-T6 aluminum with tin-zinc alloy plated L Nickel rivets after exposure to elevated temperatures of 430°F and 515°F.

TEST SPECIMENS AND PROCEDURE: The specimens, materials and equipment used in this test are listed in Table I. The test was conducted in accordance with the procedure given in Table II.

RESULTS: The results of heat exposures and salt spray tests on X-2219-T6 assemblies are given in Table III and shown in Figures 1, 2, and 3. Table IV gives the operating conditions for the salt spray chamber during specimen exposure.

DISCUSSION: Table III and Figures 1, 2 and 3 show that assemblies of sulfuric acid anodized X2219-T6 aluminum with tin-zinc alloy plated L-nickel rivets will not pass 250 hour salt spray tests after four hours exposure to either 430° or 515°F. This indicates that tin-zinc alloy plating alone will not satisfactorily reduce galvanic corrosion between the rivets and the anodized aluminum after such heat soaks. However, similar assemblies which received brush coatings of Alodine 400 in rivet holes and had the plated rivets applied with wet D.C. XP-214 primer exhibited no galvanic corrosion in salt spray tests after a heat soak at 430°F and only traces of corrosion after a heat soak at 515°F. Visual examination of specimens sectioned along the center line of each row of rivets revealed no pits in rivet holes on the assemblies which received the additional treatments. Since no damage of rivets or rivet holes was noted in assemblies using Alodine 400 and D.C. XP-214 primer, it is concluded that such assemblies have satisfactory corrosion resistance after heat soaks at temperatures up to 515°F.

CONCLUSIONS: (1) Assemblies of sulfuric acid anodized X2219-T6 aluminum with tin-zinc alloy plated L-nickel rivets will not pass 250 hour salt spray tests after exposure to either 430° or 515°F.

(2) Similar assemblies having brush coatings of Alodine 400 in rivet holes and plated rivets inserted with wet D.C. XP-214 primer will pass 250 hours salt spray tests after a heat soak at 430°F. The assemblies (with the above treatments) show minor galvanic corrosion after 250 hour salt spray tests following heat soak at 515°F, but are considered satisfactory for use.

The tests described in this report were conducted between 8 December 1958 and 6 March 1959.

WITNESS:

DATE: 27 March 1959

BY

CHECKED

APPROVED

*J. L. Coyart*

*E. W. Farn*

*REN KE*

TABLE I

## SPECIMENS, MATERIALS AND EQUIPMENT

I. SPECIMENS:SOURCE:

X-2219-T6 Aluminum (Bare)  
Type II anodized by Anadite  
Inc., Hurst, Texas

Aluminum Company of America  
Davenport, Iowa

L-Nickel Rivets (PN-134-110)  
with Tin-zinc Alloy Plating

Plant Stock Item  
(Convair-Fort Worth)

II. MATERIALS:

Tin-Zinc plating  
solution (See Table II for  
composition)

Prepared from Chem. Lab.  
Chemicals

Alodine 400  
(See Table II for composition)

American Chemical Paint Company  
Ambler, Pa.

DC XP214 primer

Dow Chemical Company  
Houston, Texas

III. EQUIPMENT:SOURCE:

Salt Spray Chamber

Ind. Filter and Pump Mfg. Co.  
Chicago, Ill.

Blue "M" oven  
(Room Temperature to 515°F)

Blue "M" Electric Company  
Blue Island, Ill.

Electroplating Table

Convair Manufactured Chem.  
Lab. Equipment

TABLE II

PROCEDURE FOR TESTING OF SPECIMENS

(A) PREPARATION OF ASSEMBLY COMPONENTS:

The X2219-T6 aluminum alloy was given a Type II anodize (sulfuric acid) by Anadite Inc., Hurst, Texas in accordance with MIL-A-8625A. The L-nickel rivets received alloy tin-zinc plating as specified in Metal and Thermit Data Sheet No. 107. The concentrations and operating conditions are as follows:

SOLUTION:

Potassium Stannate - - 16.0 oz/gal.  
Zinc Cyanide - - 1.5 "  
Potassium Cyanide - - 4.0 "  
Free Potassium Hydroxide 1.0 "  
Temperature --- 150° ± 5°F  
Cathode C.D. - 10-75 amps/ft<sup>2</sup>  
Anode C.D. - 15-25 amps/ft<sup>2</sup>  
D.C. Voltage - 4-5  
Anode - 80% tin, 20% zinc

Note: Anodes must be filmed (light yellow color on surface) so that tin will enter solution as stannate. The "filming" is accomplished by impressing a current somewhat higher than normal for a short time (about 1 minute). The current is then cut back to normal. During the filming operation the voltage will increase abruptly with corresponding decrease in ammeter reading.

(B) ASSEMBLY:

Eleven anodized X-2219-T6 aluminum pieces, each being 1" x 2", had 5 holes drilled in them. The pieces were then assembled as follows:

- (1) Two assemblies (2 pieces anodized X-2219-T6 alloy per assembly) were fastened together using tin-zinc alloy plated L-nickel exploding rivets.
- (2) Three assemblies ( 2 pieces anodized X-2219-T6 alloy per assembly) received brush coatings of Alodine 400 in each of the drilled holes. The concentration and operating conditions of the Alodine 400 solution are as follows:

TABLE II - Continued

- (B) (2)(a) Alodine powder No. 40 - 7.1 grams/gal.
- (b) Alodine liquid No. 400 - 20% by vol.
- (c) Temperature - 100° to 125°F
- (d) Immersion time - 1 to 3 minutes

Tin-zinc plated L-nickel rivets were inserted with wet DC XP-214 silicone primer. The rivets were then exploded.

- (3) One piece without holes or rivets was retained as a control specimen.

(C) HEAT EXPOSURE:

The above assemblies were exposed to heat as shown in Table III.

- (D) All assemblies in (C) above were exposed to 250 hours salt spray\* exposure per FTMS 151, Method 811. Visual examinations and photographs were made of the specimens after 50, 100, and 250 hours exposure intervals.
- (E) After completion of salt spray exposure, the assemblies were sectioned along the center line of each row of rivets and the various sectioned components were visually examined.

\* Salt spray concentration was 20%.



# CONVAIR

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TABLE II  
RESULTS OF HEAT EXPOSURE A

SPECIMEN NO.	COMPONENTS AND TREATMENTS		HEAT EXPOSURE TIME AND TEMP.	50 Hou
	X-2219-T6	L-Nickel Rivets		
1	Sulfuric Acid Anodize Per MIL-A-8625A.	Control Speci- men. No fast- ners used.	No heat exposure	No vis corros
2	Sulfuric Acid Anodize per MIL-A-8625A. No treatment of rivet holes.	5 Tin-zinc Alloy plated rivets. No XP214 primer used.	4 Hours at at 430°F	No vis corros
3	"	"	4 Hours at 515°F	Very s rosion around locati
4	Sulfuric Acid Anodize per MIL-A-8625A. Alodine 400 Brush coat on rivet holes.	5 tin-zinc alloy plated rivets, inserted wet with XP214 primer prior to explod- ing.	No heat exposure	No vis rosion
5	"	"	4 Hours at 430°F	"
6	"	"	4 Hours at 515°F	"
* Countersink				

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TABLE III

HEAT EXPOSURE AND SALT SPRAY TEST

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REPORT NO. FTL 1-1199

MODEL B-33

DATE 27 March 1959

URE EMP.	RESULTS OF SALT SPRAY EXPOSURES		
	50 Hours	100 Hours	250 Hours
posure	No visible corrosion	No visible corrosion	No visible corrosion
	No visible corrosion	Very slight corrosion of X2219 visible around all 5 rivet locations.	Increased corrosion of X2219 but less than spec. 3. No corrosion of rivets.
	Very slight corrosion of X-2219 around all 5 rivet locations.	Considerably increased corrosion of X-2219.	Severe corrosion of X2219. Sectioned pieces have deep pits in CSK.* of rivets holes. No corrosion of rivets.
	No visible corrosion	No visible corrosion	No visible corrosion.
	"	"	"
	"	"	Very slight corrosion of X2219 around 2 rivets. Sectioned pieces had no pits in CSK*. of rivet holes. No corrosion of rivets.

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Test No. F-8198  
W. O. 575-17-506

Test No. F-8198

W. O. 575-17-506

Engineer I. I. Cozart  
Prepared by

Prepared by J. L. Cozart

**FORT WORTH**

TABLE IV

## SALT SPRAY DATA AND RESULTS

Cabinet No. 2

**PAGE** 6

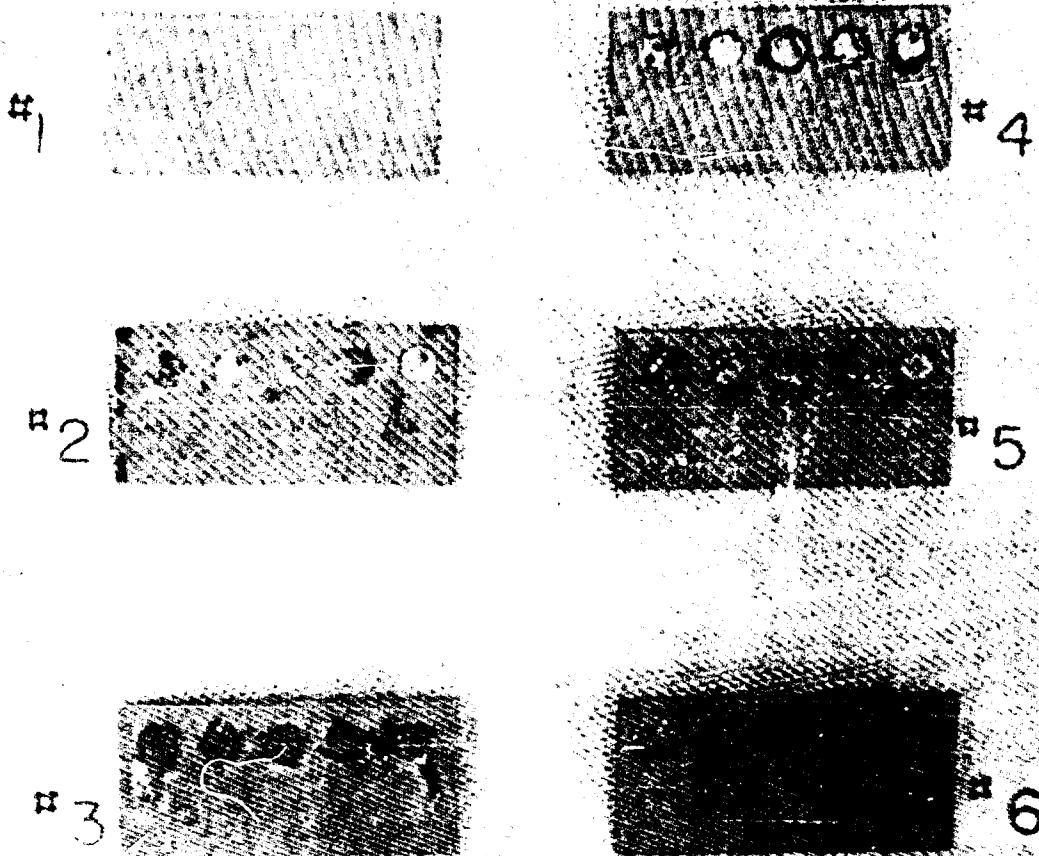
REPORT NO. FTDM2199

**BOOM B-58**

DATE 27 March 195

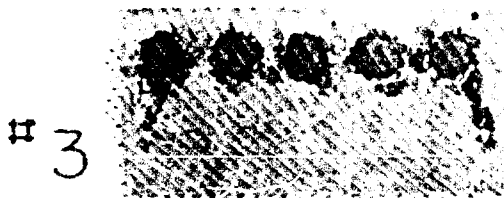
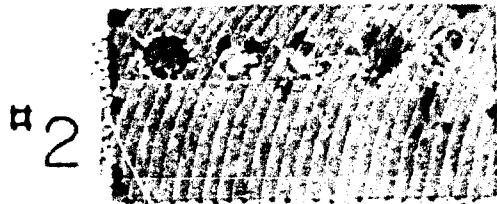
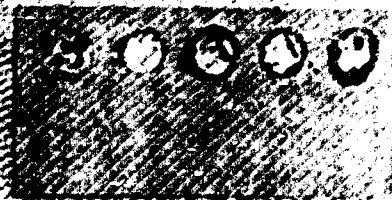
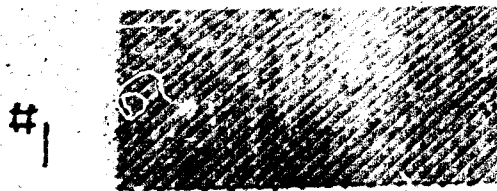
TEMPERATURE OF BOX		AIR GAUGE PRESSURE	TEMPERATURE OF HUMIDIFIER	SPECIFIC GRAVITY OF SALT SOLUTION	SPECIFIC GRAVITY OF FOG SOLUTION	ML FOG/HR. COLLECTED IN 10 CM FUNNEL	PH OF SALT SOLUTION	PH OF FOG SOLUTION	INTERRUPTIONS			
°F	psi		°F						DATE	TIME OPENED	TIME CLOSED	REASONS
MAXIMUM 97	12		110	1.157	1.150	1.2	7.2	7.2				
MINIMUM 92	12		100	1.149	1.140	0.9	6.5	6.5				
I. DESCRIPTION OF SPECIMENS AND/OR PARTS												
Size: 1" x 2" Assemblies												
Alloy and Condition: X-2219-T6 Aluminum and L-Nickel Rivets												
Coating, Finish, or Plate: X-2219 - (Type II Anodize); Rivets (Tin-Zinc)												
Edges Sealed With: None												
Pre-Exposure Cleaning: None - Handled with clean white cotton gloves.												
II. No. of Specimens: 6												
III. Reason for Test or Use of Part: As specified in Test Request.												
IV. Exposure Time: 250 hours												
Date and Time in Chamber: 16 Feb. 1959 - 23 Feb. 1959 - 26 Feb. 1959												
Date and Time out of Chamber 18 Feb., 1959 - 25 Feb. 1959 - 4 Mar. 1959												
V. Method of Specimen Support: Specimens suspended 6° from vertical in non-corrosive plexiglass rack.												
VI. Results and Remarks: See report												
Salt spray chamber opened about 20 minutes daily for additions and to take samples.												

# EFFECT OF 50 HOURS SALT SPRAY EXPOSURE



BARE 2219 T6		L-NICKEL RIVET
SPECIMEN NO.	TREATMENTS	TIN-ZINC PLATED
#1 NO HEAT	SULFURIC ACID ANODIZE	NO RIVETS
#2 * 430°F	SULFURIC ACID ANODIZE	5 (PLATED)
#3 * 515°F	SULFURIC ACID ANODIZE	5 (PLATED)
#4 NO HEAT	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP214
#5 * 430°F	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP214
#6 * 515°F	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP214

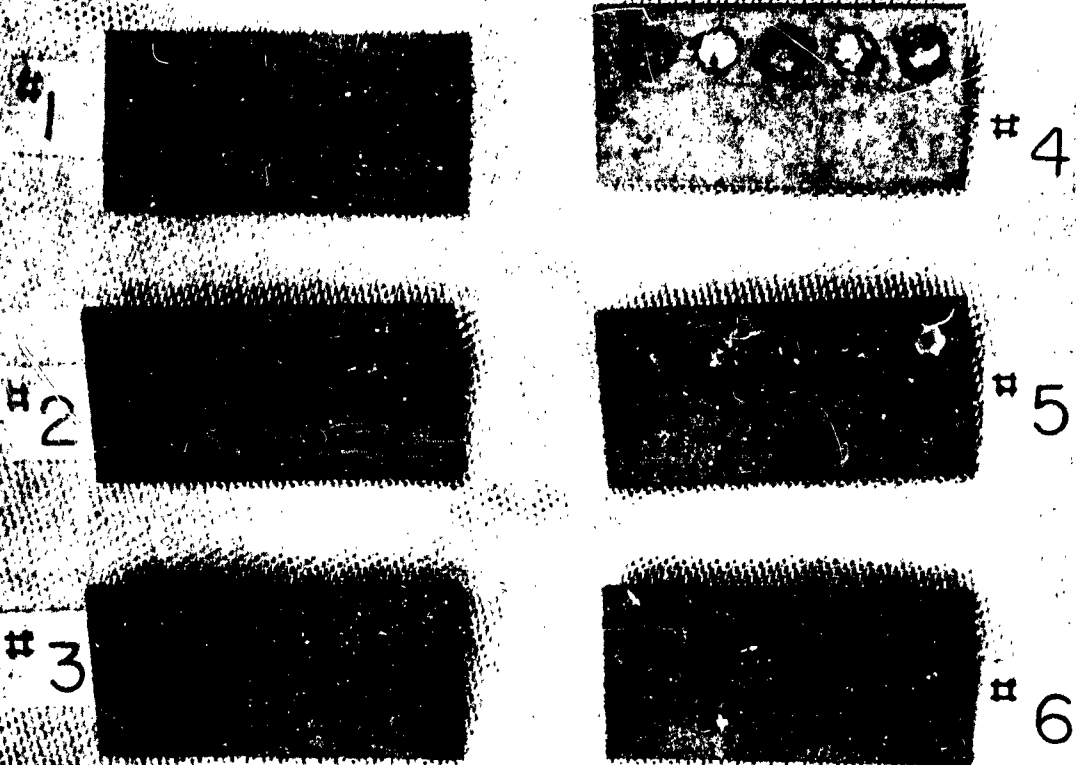
# EFFECT OF 100 HOURS SALT SPRAY EXPOSURE



BARE 2219 T6		L-NICKEL RIVET
SPECIMEN NO.	TREATMENTS	TIN-ZINC PLATED
#1 NO HEAT	SULFURIC ACID ANODIZE	NO RIVETS
#2 * 430°F	SULFURIC ACID ANODIZE	5 (PLATED)
#3 * 515°F	SULFURIC ACID ANODIZE	5 (PLATED)
#4 NO HEAT	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP214
#5 * 430°F	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP214
#6 * 515°F	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP214

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# EFFECT OF 250 HOURS SALT SPRAY EXPOSURE



BARE 2219 T6		L-NICKEL RIVET
SPECIMEN NO.	TREATMENTS	TIN-ZINC PLATED
#1 NO HEAT	SULFURIC ACID ANODIZE	NO RIVETS
#2 * 430°F	SULFURIC ACID ANODIZE	5 (PLATED)
#3 * 515°F	SULFURIC ACID ANODIZE	5 (PLATED)
#4 NO HEAT	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP 214
#5 * 430°F	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP 214
#6 * 515°F	SULFURIC ACID ANODIZE ALODINE 400 IN HOLES	5 (PLATED) INSERTED WITH WET DC XP 214

\* EXPOSED TO HEAT FOR 4 HOURS.